FILE

Washington State Department of Transportation

Memorandum

April 8, 2004

TO: Randy Simonsen
Northwest Region, MS NB 82-77

FROM: Tony M. Allen/Mark A. Frye
E&EP Geotechnical Division, 47365

SUBJECT: SR-20, MP 27.61 to 31.00, 0L-3678
Sidney St. Vic. to Scenic Heights Rd. Vic.
Retaining Wall, Station C 177+20 (24' Rt.) to C 179+00 (24' Rt.)
Geotechnical Recommendations

As you requested, we are providing geotechnical recommendations for the proposed retaining wall associated with the subject project. The project vicinity is shown on Figure 1.

The analyses, conclusions, and recommendations presented in this memorandum are based on the project description and site conditions that existed at the time of the field exploration. We assume the exploratory borings represent the subsurface conditions throughout the project area. If different subsurface conditions are encountered or appear to be present, we should be contacted so that we can reevaluate our recommendations and assist you.

PROJECT DESCRIPTION

This project proposes to improve the safety and reduce the number of accidents on the stretch of SR 20 from MP 27.61 to MP 31.00. The work of this project will involve changes in the vertical and horizontal alignments and widening of the existing roadway. An existing retaining wall between stations C 177+20 (24' Rt.) and C 179+00 (24' Rt.) will be replaced to allow for widening of SR 20 and construction of new sidewalks. The proposed retaining wall is approximately 180 feet in length and has a maximum height of 12.6 feet.

The existing retaining wall supports SR 20. A private residence below the wall is accessed by a driveway immediately north of the wall. The existing retaining wall is a soldier pile wall with concrete lagging. The existing wall does not have a fascia and the soldier piles and lagging are exposed. There is no evidence of tie-back anchors. The steel section size and the depth of embedment of the existing soldier piles are not known.

FIELD INVESTIGATION

Two exploratory borings were advanced in the vicinity of the existing wall by the Northwest Region Materials Laboratory. The test holes were located under the direction of the E&EP Geotechnical Division. Boring TH-6-03 was advanced on the shoulder of SR 20, on top of the wall near the south end of the wall. Boring TH-7-03 was advanced at the base of the wall near the north end of the wall. The locations of the test borings are shown on Figure 2. Soil properties were based on the field testing and visual descriptions of the samples. No laboratory testing was conducted on the samples. The boring logs are included in Appendix B. The boring logs should be included in the contract documents.

SUBSURFACE CONDITIONS

The field explorations indicate two basic soil units in the vicinity of the wall. These units are graphically depicted on Figure 2 and are described as follows:

Unit 1 consists of loose, silty sand with gravel. This unit is fill material placed during construction of the highway.

Unit 2 consists of dense to very dense poorly graded sand and silty sand with gravel. This unit was encountered below Unit 1 to the extent of the explorations.

Groundwater was recorded at a depth of 40 feet (approximately elevation 96 feet) below the roadway in boring TH-6-03. No groundwater was recorded in boring TH-7-03.

GEOTECHNICAL RECOMMENDATIONS

We understand a soldier pile wall is the preferred alternative to replace the existing wall and minimize impacts to traffic on SR 20, and private property below the wall. Soldier pile and lagging design should be performed by the Bridge and Structures Office using the earth pressure diagram provided on Figure 3 in Appendix A. Minimum pile embedment to provide adequate global stability of the wall system is also provided on this figure. A resistance factor of 1.0 should be applied to the nominal passive earth pressures on this figure (per AASHTO LRFD Bridge Design Specifications).

If the new wall is constructed in front of the existing wall, the gap between the two walls should be filled with a free draining, self-compacting material such a pea gravel (AASHTO Grading No. 7, Section 9-03.1(4) C in the Standard Specifications). Above the existing wall, the new wall can be backfilled with gravel borrow.

If this wall is constructed in the same location as the existing wall, the new soldier piles should be located between the existing piles. The existing soldier piles should be cut off at the bottom of wall elevation. No attempt should be made to remove the embedded portion of the existing soldier piles. The wall should be backfilled with gravel borrow.

CONSTRUCTION CONSIDERATIONS

If this wall is constructed on the same alignment as the existing wall, the soils behind the existing will have to be excavated and the lagging removed prior to installation of the new soldier piles. The soils behind the existing wall may not be stable at slopes steeper than 1.75:1 (Horizontal:Vertical). Temporary excavations up to 1:1 may be stable for short periods of time. The contract provisions should limit the amount of excavation to a length that can be backfilled in one shift. Temporary shoring at the back of the new soldier piles could be used to allow temporary backfill of the excavation as necessary.

The granular Unit 2 soils may cave during excavation of the soldier pile shafts. The Contractor should be prepared to handle caving soils with temporary casing or drilling slurry.

If you have questions or require further information, please contact Tony Allen at (360) 709-5450 or Mark A. Frye at (360) 709-5469.

TMA/maf
Attachment: Appendix A: Figures
Appendix B: Boring Logs

cc: Chris Johnson, Northwest Region Materials Engineer, MS NB 82-29
John VanLund, Bridge and Structures, NB 47340

Appendix A

Figures

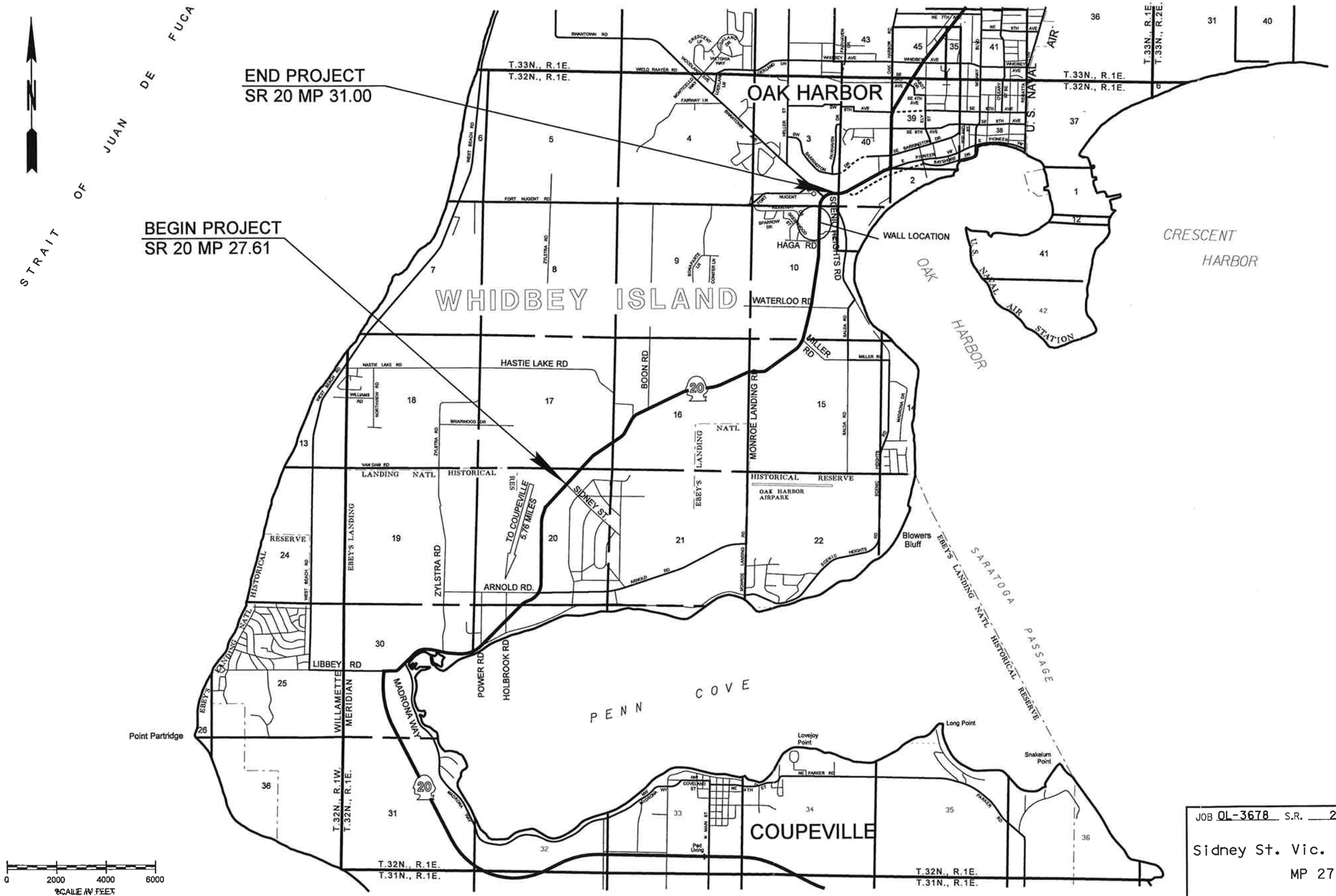

Figure 1: Vicinity Map

JOB OL-3678 S.R. 20 C.S. _____

Sidney St. Vic. to Scenic Heights Rd. Vic.
MP 27.61 to MP 31.00

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 3/2004
SCALE N.T.S. VERT. HORIZ.
SHEET ___ OF ___
DRAWN BY W.M.

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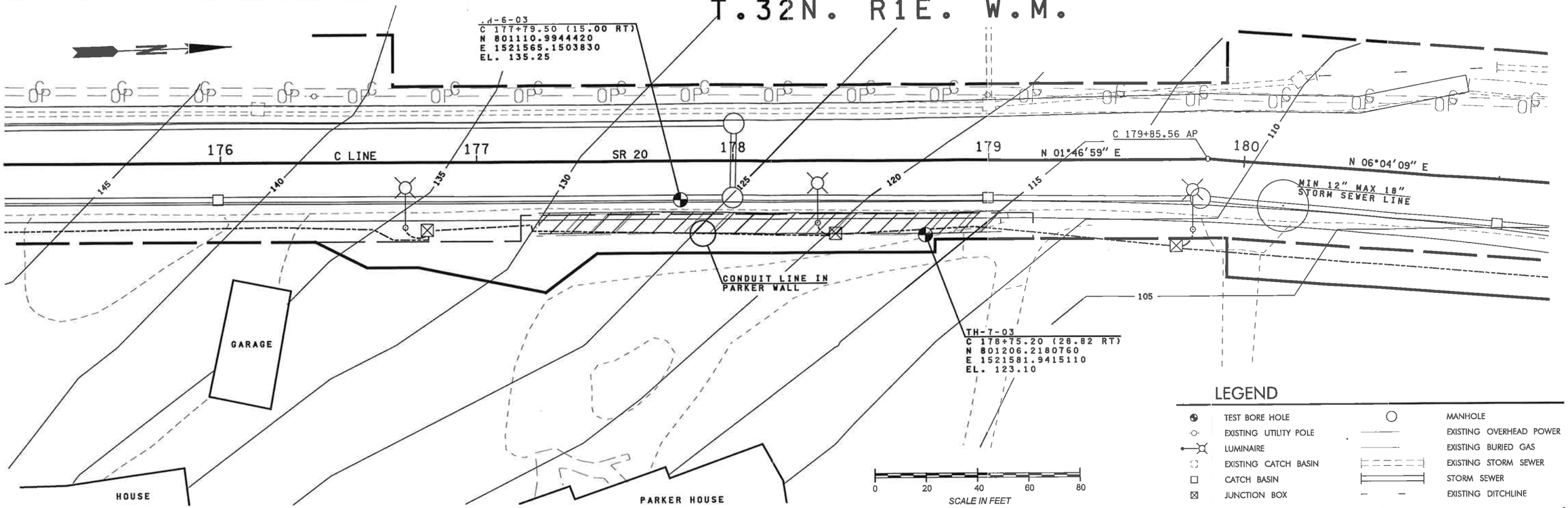
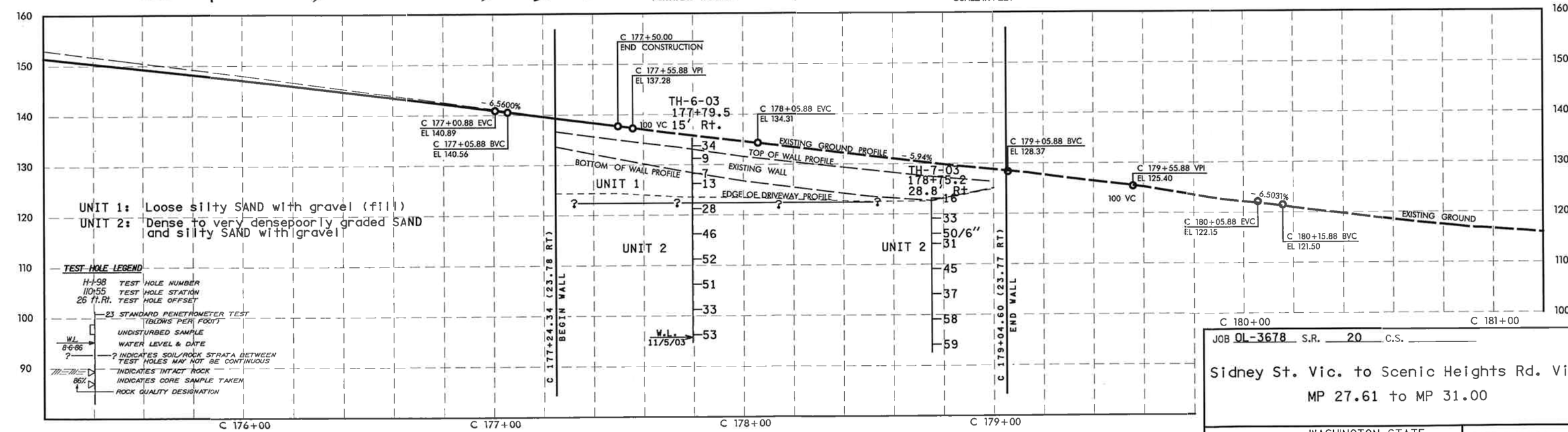
T.32N. R1E. W.M.



LEGEND

- TEST BORE HOLE
- EXISTING UTILITY POLE
- LUMINAIRE
- EXISTING CATCH BASIN
- CATCH BASIN
- JUNCTION BOX
- MANHOLE
- EXISTING OVERHEAD POWER
- EXISTING BURIED GAS
- EXISTING STORM SEWER
- STORM SEWER
- EXISTING DITCHLINE



UNIT 1: Loose silty SAND with gravel (fill)
UNIT 2: Dense to very densepoorly graded SAND and silty SAND with gravel

TEST HOLE LEGEND

- H-I-98 — TEST HOLE NUMBER
- 110+55 — TEST HOLE STATION
- 26 ft.Rt. — TEST HOLE OFFSET
- 23 — STANDARD PENETROMETER TEST (BLOWS PER FOOT)
- UNDISTURBED SAMPLE
- W.L. 8-6-86 — WATER LEVEL & DATE
- ? — INDICATES SOIL/ROCK STRATA BETWEEN TEST HOLES MAY NOT BE CONTINUOUS
- INDICATES INTACT ROCK
- 86% — INDICATES CORE SAMPLE TAKEN
- ROCK QUALITY DESIGNATION

DATUM
(NAVD) 83/91

Figure 2: Site Plan and Wall Profile

JOB OL-3678 S.R. 20 C.S.

Sidney St. Vic. to Scenic Heights Rd. Vic.
MP 27.61 to MP 31.00

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 3/2004
SCALE 1=20' VERT.
1=40' HORIZ.
SHEET ___ OF ___
DRAWN BY W.M.

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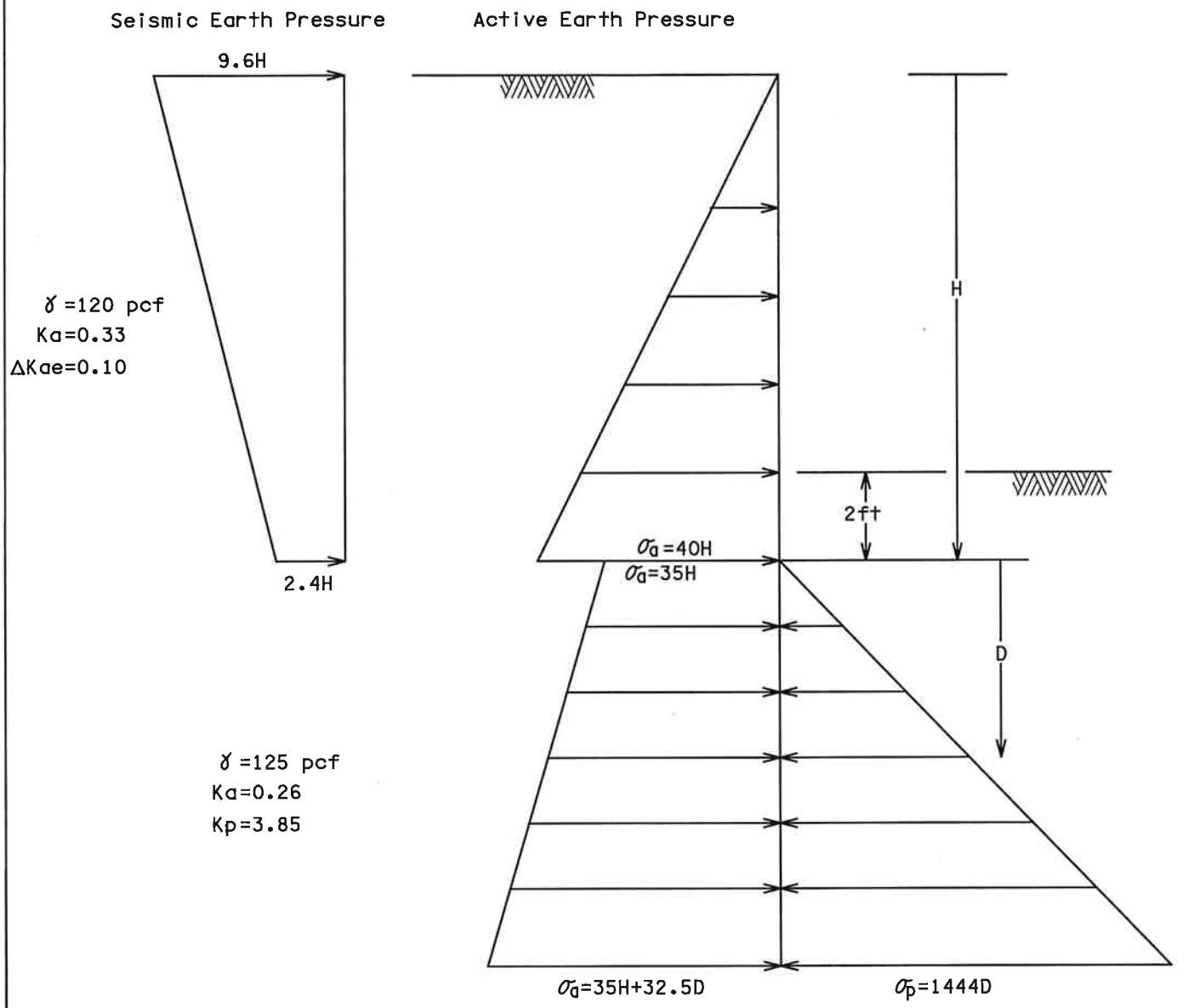

NOTES

1: Active pressure below bottom of lagging acts over one pile width.
2: Passive pressure shown should be applied over one pile width.
3: $\sigma_p = 3K_p\gamma D$: The passive pressure assumes the pressure acts over 3 pile diameters and are unfactored.
4: Ignore passive pressure below finished grade in front of wall for a distance of 2ft.
5: All pressure in pounds per square foot (psf).
6: Extend lagging 2 feet below finished grade in front of wall.
7: Minimum embeddment length D=10ft.

Figure 3: Earth Pressure Diagram

JOB 01-3678 S.R. 20 C.S. _____ LAYOUT _____

Sidney St. Vic. to Scenic Heights Rd. Vic.
MP 27.61 to MP 31.00

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 3/2004
SCALE N.T.S. VERT. HORIZ.
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Appendix B

Field Exploration

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Washington State
Department of Transportation

Test Boring Legend

Sampler Symbols

	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Bottom Seal
	Inclinometer Casing in Concrete Bentonite Grout

Laboratory Testing Codes

UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
UC	Unconfined Compression Test
DS	Direct Shear Test
CN	Consolidation Test
GS	Grain Size Distribution
MC	Moisture Content
SG	Specific Gravity
OR	Organic Content
DN	Density
AL	Atterberg Limits
PT	Point Load Compressive Test
SL	Slake Test
DG	Degradation
LA	LA Abrasion

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, somtimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCL Reaction

No HCL Reaction	No visible reaction.
Weak HCL Reaction	Some reaction with bubbles forming slowly.
Strong HCL Reaction	Violent reaction with bubbles forming imediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

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Washington State
Department of Transportation

Test Boring Legend

Grain Size

Fine Grained	< 1mm	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	1mm to 5mm	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 5mm	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	1 to 25 MPa
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	25 to 50 MPa
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	50 to 100 MPa
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	100 to 200 MPa
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 200 MPa

Discontinuities

Spacing

Very Widely	Greater than 3 m
Widely	1 m to 3 m
Moderately	0.3 m to 1 m
Closely	50 mm to 300 mm
Very Closely	Less than 50 mm

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition

Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 1 mm, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 1 mm, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 5 mm thick, or open discontinuities 1 to 5 mm.
Very Poor	Soft gouge greater than 5 mm thick, or open discontinuities greater than 5 mm.

Fracture Frequency (FF) is the average number of fractures per 300 mm of core.
Does not include mechanical breaks caused by drilling or handling.

Washington State Department of Transportation

LOG OF TEST BORING

Start Card SE00645

HOLE No. TH-6-03

Sheet 1 of 2

Job No. OL-3678 SR SR-20 Elevation 135.3 ft (41.2 m)

Project Sidney St. Vicinity to Scenic Heights Rd. Vicinity.

Driller Jody Dickson Lic# 2637T

Site Address

Inspector Brian M Breck

Start November 5, 2003 Completion November 5, 2003 Well ID#

Equipment CME 45 w/ autohammer

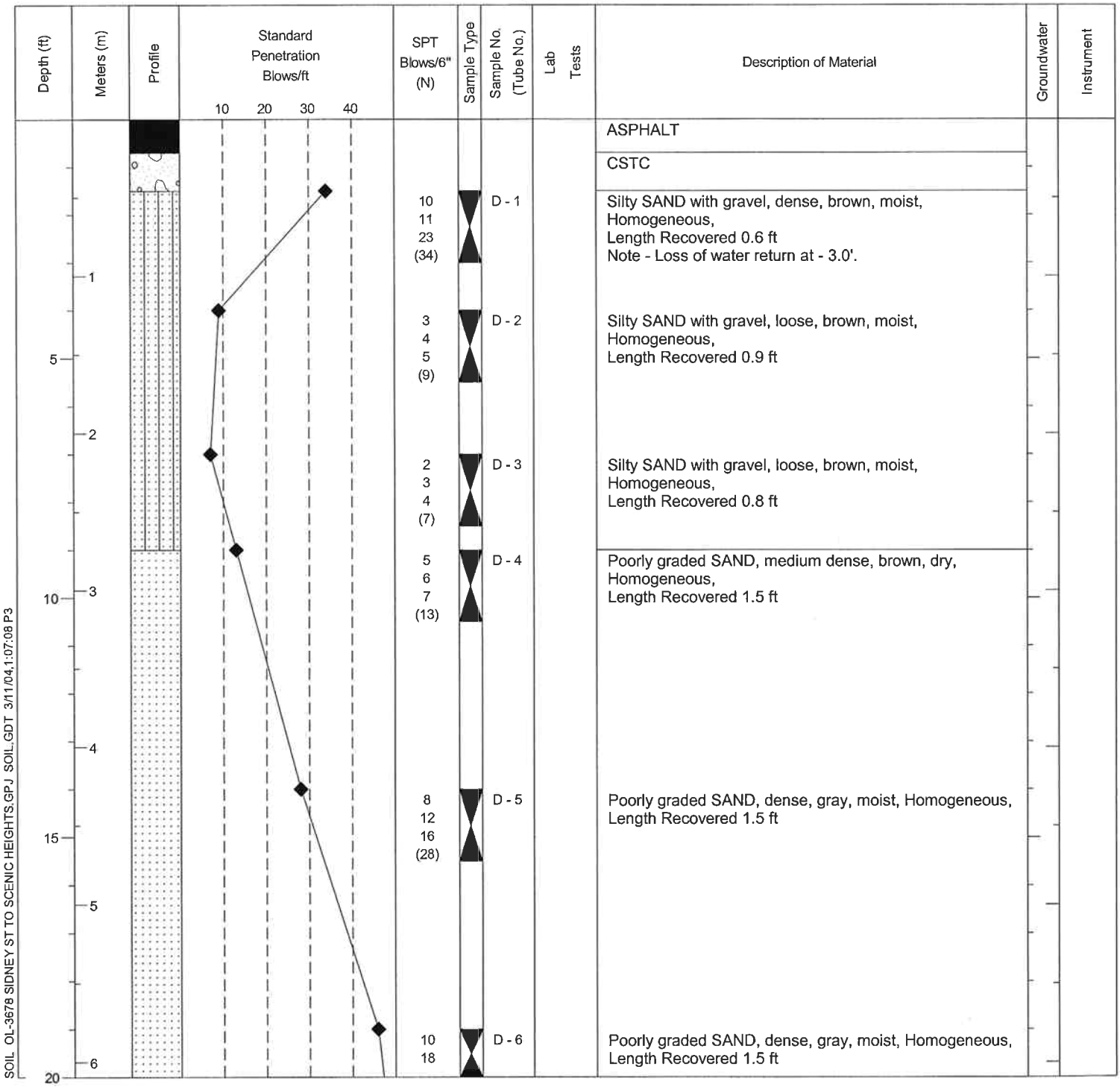
Station 177+79.5 Offset 15' Rt. Casing HQ x 42

Method Wet Rotary

Northing 801110.994442 Easting 1521565.150383 Latitude

Longitude

County Island Subsection SE 1/4 of the SW 1/4 Section 3 Range 1E Township 32



Washington State Department of Transportation

LOG OF TEST BORING

Start Card SE00645

HOLE No. TH-6-03

Job No. OL-3678 SR SR-20 Elevation 135.3 ft (41.2 m)

Sheet 2 of 2

Project Sidney St. Vicinity to Scenic Heights Rd. Vicinity.

Driller Jody Dickson Lic# 2637T

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			28 (46)						
	7	>>	14 22 30 (52)		D - 7		Poorly graded SAND, very dense, gray, moist, Homogeneous, Length Recovered 1.5 ft		
25	8								
		>>	15 25 26 (51)		D - 8		Poorly graded SAND, very dense, gray, moist, Homogeneous, Length Recovered 1.5 ft		
30	9								
	10								
35			11 16 17 (33)		D - 9		Poorly graded SAND, dense, gray, moist, Homogeneous, Length Recovered 1.5 ft		
	11								
		>>	21 25 28 (53)		D - 10		Poorly graded SAND, very dense, gray, wet, Homogeneous, Length Recovered 1.5 ft	▽	
40	12						11/05/2003		
							End of test hole boring at 40.5 ft below ground elevation.		
	13						This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
45									

SOIL OL-3678 SIDNEY ST TO SCENIC HEIGHTS.GPJ SOIL.GDT 3/11/04 1:07:09 P3

Washington State Department of Transportation

LOG OF TEST BORING

Start Card SE00645

HOLE No. TH-7-03

Sheet 1 of 2

Job No. OL-3678 SR SR-20 Elevation 123.1 ft (37.5 m)

Project Sidney St. Vicinity to Scenic Heights Rd. Vicinity.

Driller Jody Dickson Lic# 2637T

Site Address

Inspector Brian M Breck

Start November 6, 2003 Completion November 7, 2003 Well ID#

Equipment CME 45 w/ autohammer

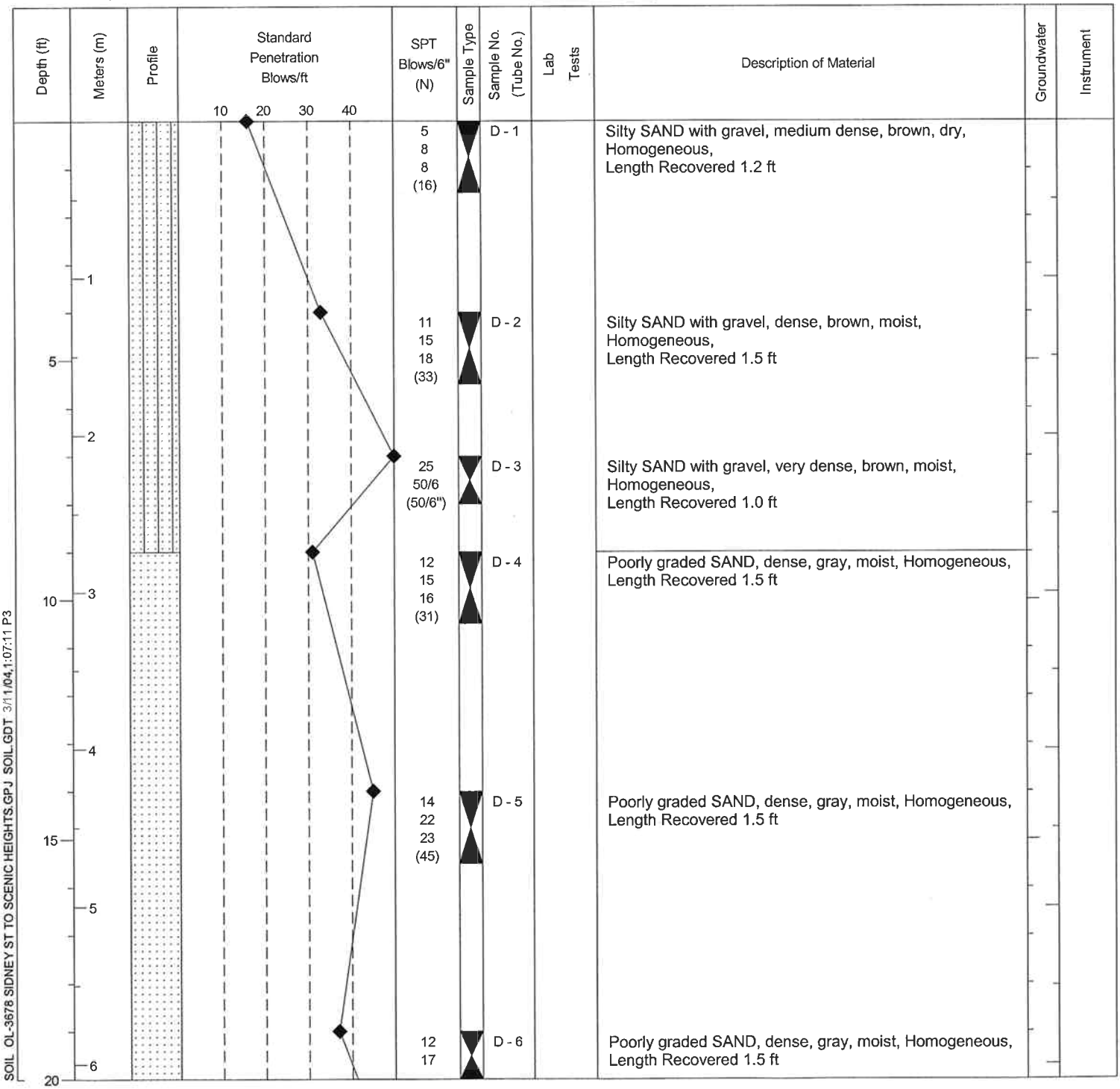
Station 178+75.2 Offset 28.8' Rt Casing HQ x 32

Method Wet Rotary

Northing 801206.218076 Easting 1521581.941511 Latitude

Longitude

County Island Subsection SE 1/4 of the SW 1/4 Section 3 Range 1E Township 32



SOIL OL-3678 SIDNEY ST TO SCENIC HEIGHTS.GPJ SOIL.GDT 3/11/04,1:07:11 P3

Washington State Department of Transportation

LOG OF TEST BORING

Start Card SE00645

HOLE No. TH-7-03

Job No. OL-3678 SR SR-20 Elevation 123.1 ft (37.5 m)

Sheet 2 of 2

Project Sidney St. Vicinity to Scenic Heights Rd. Vicinity.

Driller Jody Dickson Lic# 2637T

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				20 (37)						
	7		>>	16 26 37 (58)		D - 7		Poorly graded SAND, very dense, gray, moist, Homogeneous, Length Recovered 1.5 ft		
25	8									
			>>	17 27 32 (59)		D - 8		Poorly graded SAND, very dense, gray, moist, Homogeneous, Length Recovered 1.5 ft		
30	9							End of test hole boring at 30.5 ft below ground elevation.		
	10							This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
35	11							No Free Water.		
	12									
40	13									
45										

SOIL OL-3678 SIDNEY ST TO SCENIC HEIGHTS.GPJ SOIL.GDT 3/11/04,1:07:11 P3